InSpector Portable Spectroscopy Workstation

Features

- Laboratory grade spectroscopy workstation in a compact, battery powered configuration
- Full day operation on one set of batteries
- Ping-pong dual battery feature allows uninterrupted operation
- Sophisticated battery power management
- 8192-channel ADC and memory
- Fully programmable electronics, including high voltage range and polarity selection
- Spectroscopy grade amplifier with auto pole/zero
- Digital gain and zero stabilization
- Pileup rejector and live time corrector
- User interface via notebook type PC
- Full featured Genie-2000 and Genie-PC based acquisition and analysis software
- Routine count procedures with the PROcount environment
- Compatible with all Genie-2000 and Genie-PC options

Description

The InSpector is a full featured 8192-channel, battery-powered, portable Multichannel Analyzer. When paired with the notebook computer of choice, the InSpector becomes a full featured spectroscopy workstation, capable of laboratory quality acquisition and analysis. The instrument is designed for *in situ* applications using germanium or NaI(Tl) detectors.

Increasingly, spectroscopists engaged in environmental characterization, decommissioning, decontamination, waste management and nuclear safeguards are called upon to take high quality measurements under less than ideal conditions. Measurements are often taken outdoors. The operator must be able to set up the measurement, acquire and analyze data, and move quickly to the next location.

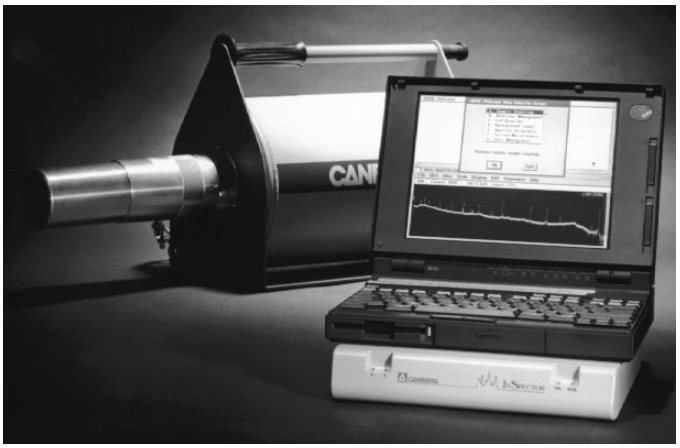
Although the conditions are less than ideal, the needs for precision and accuracy are often similar to those for a fixed laboratory system. The InSpector was designed with these requirements in mind.

Electronics are equivalent to what would be expected in laboratory equipment. The signal processing is 100% computer controlled, offering both ease of operation and assurance of consistent operation. The widely accepted Genie-PC software environment, standard on the InSpector, provides robust analysis capabilities, extensive Quality Assurance and automation capabilities for proceduralized counting.

All this in the smallest, lightest spectroscopy system available today. Extensive use of surface mount technology (SMT), low power circuitry and sophisticated power management make the InSpector ideal for field use.

Many labs with both portable and lab needs will select the InSpector for both; count routinely in the lab and get superior results, take the unit to the field for on-site application.

Electronics
All front end electronics of this MCA are programmable. The InSpector features a spectroscopy amplifier, a stable software selectable high voltage power supply with dual range for Ge and NaI(Tl) detectors, a digital stabilizer, and an 8192-channel ADC. The data memory is kept alive with an internal lithium battery to prevent loss of data.



Full computer control of the front end eliminates physical switching of modules or jumpers. Functions such as changing the detector bias and reversing the high voltage polarity are software controlled as well. The user will never have to open the instrument to initiate changes in operating parameters.

The amplifier allows variable shaping time selections of 1 or 4 µs to meet fast or slow pulse shaping requirements. Pole/zero, base line restorer and discriminator threshold adjustments are fully automatic.

A digital stabilizer provides both zero and gain stabilization. The stabilizer is programmable and allows adjustments interactively. The user can turn the stabilizer on or off from the setup menus to suit specific applications. The software can remember stabilizer adjustments and the user can simply "Hold" these adjustments during successive counts (provided the operating conditions are similar).

The electronics will withstand the rugged operating environment of a portable application. Extensive use of surface mount technology ensures stability and physical integrity of all internal components.

Physical setup of the instrument is simple. The instrument uses minimum interconnects, cables and switches. A single composite cable is provided for the detector with a "quick disconnect" type latch. A standard 9-pin EIA connector is provided for the computer. An on/off switch is the only physical control.

The location of all connectors enables quick connection or disengagement of cables.

User Interface
The user interface is provided through a notebook size personal computer. The computer is detachable during data acquisition. The user has the full freedom to choose a specific computer that meet the instrument requirements, and upgrade to newer models when desired.

A status display panel on the acquisition unit displays all vital information to its user. Brightly colored, well-positioned status LEDs provide battery state and instrument status information. A total of four LEDs covers the critical status of the instrument – the two battery states, the acquisition status, and the high voltage status.

Software
A special version of the popular Canberra Genie-2000 and Genie-PC software has been designed for the InSpector. The InSpector features

sophisticated peak search and optional nuclide identification capability, with a special version of the PROcount batch counting procedures.

PROcount procedures are tailored specifically to the needs of *in situ* applications. PROcount offers a very flexible batch environment for customized, routine operations. Flexibility was a key design objective behind the software development of the InSpector. A facility manager can use the graphical batch management capability to setup application menus congruent to the needs of field operators.

In the InSpector, setup and configuration menus are accessed through appropriate menus. These menus can be password protected to prevent unauthorized or inadvertent changes in system setup. Hardware and logical parameter selections are easy once the user is in the appropriate screen.

Detailed information on a sample, counting history, proof of correct instrument setup, calibration, and other quality assurance requirements are vital to many facilities. The "CAM" files address this need. Inherent to the Genie family this CAM file is based on the "Configuration Access Method" whereby all information associated with a count becomes part of a disk file. Thus, the software automatically stores all sample information, front end setup parameters, and calibration information with the data (or analysis results) in a single CAM file.

The CAM file eliminates the need for paper trails on samples and setup information. Such a reliable form of record keeping satisfies regulatory requirements and allows the operator to make more efficient use of time.

See separate specification sheets on Genie-2000 and Genie-PC for more details.

Packaging
The InSpector is 26.9 cm (10.6 in.) wide, 27.2 cm (10.7 in.) deep, 4.8 cm (1.9 in.) high and weighs 3.2 kg (7.0 lb) with dual batteries.

Batteries
The batteries are commercially available Sony compatible camcorder type batteries. These batteries are 5 cm (2 in.) long and 3.8 cm (1.5 in.) thick, and allow approximately three hours of full powered operation. Replacements are available in most camera or hardware stores.

The battery ports are external, with easy access. Dual batteries ensure uninterrupted operation as the user can change one while the other maintains power to the instrument. Two batteries and a fast battery charger accompany the instrument.

Power Management
A unique feature of the InSpector is a dual battery design with intelligent power management. The power subsystem design incorporates a dedicated microprocessor which optimizes power consumption within the instrument while continuously monitoring the status of the batteries.

Two front panel LEDs provide a complete picture of of the batteries' operation and status. Power for the instrument is always derived from one battery. The battery status LEDs indicate which battery is in use, when the battery is in a low state and when a battery is discharged or disconnected.

Continuous operation of the instrument will be assured if the battery in reserve is charged and ready to go as indicated by LED status. Uninterrupted continuous operation can be maintained indefinitely by changing the discharged battery as the power manager switches from old to new.

The instrument's power management feature is fully programmable. A power management dialog box, accessible from the software, provides all adjustments. The user can select a "Power Save" mode or a "Full Power" mode for battery operation or switch to "AC Power" operation from this dialog box. No physical adjustments are necessary.

The "Power Save" mode minimizes battery drain by automatically shedding power whenever possible. For example, if acquisition is not active, the internal signal processing electronics as well as the external detector HV and preamp are powered down. When activated, a programmable delay time is provided to hold off actual data acquisition until the internal electronics have thermally stabilized thus insuring high resolution HPGe systems are not compromised.

Another power saving feature of the "Power Save" mode is the sleep or standby state. This state is automatically entered into after prolonged unattended operation. This delay time is programmable.

The "Power Save" mode is ideal for most applications. All power management of the instrument is totally transparent to the operator. Typically, an instrument with two fully charged batteries will last the entire day.

In the "Full Power" mode all circuits are continuously kept under power. This option may be desirable for quick repetitive acquisition cycles where a stabilization lag time is an undesirable nuisance. In these situations the short powered down times can be more than offset by the programmed lag times and is therefore of little benefit. In this mode only three hours of operation can be realized.

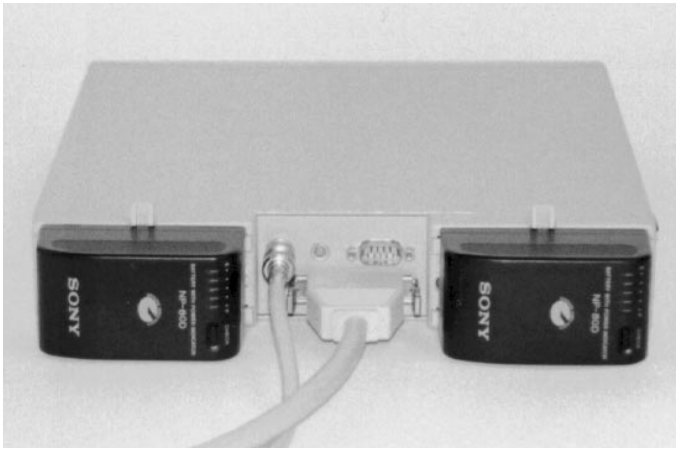
The "AC Power" mode is set for operation when ac power is available. This mode directs the power manager to operate off a single battery port. All power shedding functions are disabled. A unique feature is available with this mode: Besides directing the power manager to use the battery port with the ac adapter, an automatic switchover to the alternate battery port will occur if ac power is lost. Assuming a battery is installed, the instrument is essentially set up for battery backed ac operation.

A universal ac adapter and a fast charger are included with the instrument for off-line battery charging. Many other accessories including a 12 V cigarette lighter adapter are available from Canberra, Sony and other third party camcorder retailers.

Carrying and Storage
Carrying the instrument is similar to carrying an executive style notebook PC. A soft sided carrying case suitable for the InSpector, notebook PC and accessories is included.

A field trip involves carrying more than the analyzer. Different applications have different requirements of gadgets or tools. The compact size of the InSpector allows users to select from a wide variety of commercially available carrying cases. It also allows one to use a custom designed case for unique carrying requirements.

The instrument is light enough to be carried in an attache case.



The InSpector features dual Sony-compatible camcorder batteries and a composite, quick disconnect detector cable.

Applications

The InSpector addresses applications in environmental measurements and decommissioning operations, nuclear safeguards, and on-line monitoring.

Environmental Measurements and Decommissioning Operation

In situ measurements are integral to most environmental surveillance and site decommissioning operations. Such applications involve measurements at a site for extended periods, often from a vehicle or other temporary shelters. They also involve ultra low level measurements for environmental measurements, or relatively hot sample in the case of decommissioning operations.

The InSpector allows a full day of data acquisition by virtue of its power shedding capability. If required, the user can replenish batteries without interrupting data acquisition. Full analysis and report generation capabilities are part of the software. The front end electronics are stable and flexible enough to deal with low level measurements, or relatively high count rates.

Nuclear Safeguards

Nuclear safeguards applications prevent unauthorized proliferation of nuclear material. Regulatory Agencies routinely make *in situ* measurements during inspection trips at various nuclear sites. Data collection times are often short, and sometimes must be conducted in hostile environments.

The InSpector has been designed to facilitate travel, allowing quick setup and disassembly. The instrument allows custom batch tasks from a graphical environment to execute predetermined count/analysis sequences. The data storage mechanism is designed to store sample data, analysis results, with all relevant setup and configuration information.

On-Line Monitoring

On-line monitoring work in Nuclear Power stations involves inspections at locations within a facility. Often the size and weight of the instrument become the only limitation as power is readily available and ac power takes precedence over batteries. However, the battery powered InSpector eliminates the need for power cords or main outlets.

Specifications

INPUT/OUTPUT

DETECTOR – Rear panel weather-resistant quick-disconnect signal and power connector containing the following signals:

AMP/ADC IN – Programmed to accept preamp signals or external amplifier outputs; BNC connector.

INT AMP MODE – Accepts positive or negative tail pulses; amplitude 10 V divided by the selected gain, 25 V maximum; rise time less than shaping time constant; decay time constant: 40 μs to ∞; polarity programmable; R_{in}: 9 kΩ > R_{in} > 0.95 kΩ, R_{in} changes with Gain and Polarity setting.

EXT AMP MODE – Accepts positive unipolar or bipolar (positive lobe leading) pulses for PHA; amplitude 0 to +10 V, +12 V maximum; rise time 0.25 to 100 μs maximum; width 5 μs minimum; input impedance 1kΩ, direct coupled.

INHIBIT – Accepts a standard logic signal from an associated reset preamplifier; used to extend the Dead Time signal, inhibit and reset the pileup rejector and provide a reject to the ADC during the preamplifier's reset cycle; positive true or negative true signal polarities, programmable; Loading 4.7 kΩ; Logic High ≥3.6 V, Logic Low ≤1 V; 0 to +12 V maximum; BNC connector.

HV INHIBIT – Logic Low or ground inhibits the HV outputs; max logic low ≤0.7 V; logic high ≥2.0 V or open circuit enables; 0 to +12 V maximum; BNC connector.

PREAMP POWER – ±12 V dc, ±24 V dc.

HVPS OUT – Programmable dual range and polarity; ±5000 V dc with 100 μA output current capability or +1300 V dc with 500 μA output current capability; programmable range, resolution of 1 part in 4096; rear panel SHV connector (isolated from chassis ground by 47 Ω resistor).

DATA INTERFACE – EIA RS-232 interface to host personal computer; 9-pin connector; auto sense selection of data transfer rates (115.2, 57.6, 38.4, 19.2, 9.6, 1.2 kbaud).

CONTROLS

ON/OFF – No power is consumed in the *off* position. In the *on* position, the batteries are load tested and continually monitored with status shown by the Battery Indicator LEDs.

INDICATORS

BATTERY STATUS A, B – LEDs indicate which battery is in use, when a battery is low and when a battery is discharged/disconnected. Switch over is automatic.

HV ON – LED to indicate the presence of HV at the rear panel SHV connector.

ACQUISITION – LED to indicate acquisition in process.

BATTERY CAPACITY – LED array indicators standard on Sony Battery Pack Model NP-80D, or equivalent.

POWER SUBSYSTEM

BATTERY PACK – Dual 6 V NiCd battery packs; standard Sony Camcorder packs Model NP-80D or equivalent.

BATTERY LIFE – Approximately three hours of live acquisition time for two batteries with an HPGe detector and 2002C preamp or with an NaI detector. At a typical operating duty cycle of 50%, approximately a full day's operation can be expected.

POWER RESERVE – Battery cartridges may be changed, one at a time, without interrupting the instrument operation.

FAST CHARGER – Separate charger for standalone batteries; charge time: approximately two and one half hours.

AC ADAPTER – 110/220 V ac external supply connected to the unit in place of battery A. Battery B can be used to supply power to the instrument if ac is lost.

BATTERY BACKUP – Internal lithium battery to back up MCA memory.

POWER MANAGEMENT – An intelligent power management circuit optimizes battery life and avoids a deep discharge condition by automatic and manual power shedding techniques. Individual power modes are:

AC Power:	Programmable via computer (refer to the earlier ac adapter description).
Full Power:	Signal processing electronics under full power.
Power Save:	Turns off power to the signal processing electronics. Electronics are powered up for a user-specified time before acquisition. After acquisition is complete, the electronics are turned off again.
Standby:	Lowest power mode, during periods when there is no communication with the computer. Host computer can restore to the Power Save or Full Power modes.
Off:	Controlled by the On/Off switch only. No power is consumed in the *off* position.

LOW BATTERY SENSOR – When both batteries become fully discharged, the unit will automatically switch to the *off* state, disconnecting the batteries to prevent damage due to deep discharge.

SYSTEM CONTROL – The instrument can be manually directed into any power mode via the computer or can be set to automatically switch between Power Save and Full Power Modes corresponding to acquisition status.

PREAMP POWER – Provides power and ground for standard preamplifiers; +24 V at 40 mA, –24 V at 30 mA, +12 V at 80 mA and –12 V at 30 mA (maximum total power 2.4 W).

PERFORMANCE

HVPS

MULTI-RANGE – Programmable +5 V to +1.3 kV, +1.3 kV to +5 kV, –10 V to –5 kV; resolution to within 1 part in 4096; rear panel SHV connector.

LOAD CURRENT – 1.3 kV range: 500 μA. 5 kV range: 100 μA from 65 to 5000 V; below 65 V linearly derated at 1.3 μA per volt.

NON-LINEARITY – < ±0.3% of full scale.

RIPPLE AND NOISE AT RATED LOAD CURRENT – 1.3 kV range: ≤5 mV peak to peak; 5 kV range: ≤50 μV peak to peak.

OUTPUT STABILITY – Long term drift of output voltage is ≤0.01%/h and ≤0.02%/8 h at constant load, and ambient temperature after a 30 minute warmup.

TEMPERATURE COEFFICIENT – ≤±50ppm/°C after a 30 minute warmup.
REGULATION – ≤0.02% variation in output voltage over the load range at constant ambient temperature.
OVERLOAD PROTECTION – Power supply will withstand any overload, including a short circuit, for an indefinite period.
CURRENT LIMIT – 1.3 kV range: 1.6 mA, maximum; 5 kV range: 350 μA, maximum.
SETTLING TIME – <100 V/s, turn on or turn off.

AMPLIFIER

GAIN RANGE – Programmable from X2 to X1500, based on a 10 V full-scale output; programmable resolution of 1 part in 16 000.
SHAPING TIME – Programmable: fast (1 μs) or slow (4 μs).
POLE/ZERO – Automatic; 40 μs to ∞ range; TRP: ∞.
DRIFT –
Gain: ≤±0.0075%/°C.
d c level: ≤±7.5 μV/°C.
INTEGRAL NONLINEARITY – ≤±0.05% over total output range for 4 μs shaping.
OVERLOAD RECOVERY – Output recovers to within ±2% of full scale output from X1000 overload in 2.5 non-overload pulse widths at full gain, at any shaping time constant, and with preamplifier matching properly set.
NOISE CONTRIBUTION – 3.5 μV true rms, output referred to input, 4 μs shaping, and amplifier gain ≥150.
PULSE SHAPING – Near-Gaussian shape; one differentiator; two active filter integrators realizing five-pole shaping network; shaping time parameters referenced to 1 μs are listed in the following table:

Parameter	Shaping Time Multiplier Gaussian
Time to peak	2.85
0.1% full scale output to peak	2.3
Pulse width at half maximum	2.5
Pulse width at tenth maximum	6.1
Pulse width at 1/100 maximum	7.1

RESTORER – Active gated.
SPECTRUM BROADENING – The FWHM of ^{60}Co 1.33 MeV gamma peak for an incoming count rate of 2 kcps to 50 kcps and 90% of full scale pulse height will typically change less than 10% with 4 μs shaping selected; TRP preamplifier. These results may not be reproducible if the associated detector exhibits an inordinate amount of long rise time signals.
COUNT RATE STABILITY – The peak position of a ^{60}Co 1.33 MeV gamma peak for an incoming count rate of 2 kcps to 50 kcps and 90% of full scale pulse height will typically shift less than 0.025% with 4 μs shaping selected; TRP preamplifier.

ADC

CONVERTER – 100 MHz Wilkinson.
CONVERSION GAIN – 8192, 4096, 2048, 1024, 512, 256.
LLD – Range: 0.1 to 110% of full scale; programmable resolution of 1 part in 3152.
ULD – Range: 0 to 110% of full scale; programmable resolution of 1 part in 3155.
ZERO – Range: 0 ±5% of full scale; programmable resolution of 1 part in 3414.
INTEGRAL NONLINEARITY – <±0.025% of full scale over the top 99.5% of selected gain range.
DIFFERENTIAL NONLINEARITY – <±0.9% over the top 99.5% of selected gain range.
DRIFT –
Gain: <±0.009% of full scale/°C.
Zero: <±0.0025% of full scale/°C.
Long Term: <±0.005% of full scale/24 hours at a constant temperature.
PEAK SHIFT – <±0.025% of full scale at rates up to 100 kHz.
CHANNEL PROFILE – Typically flat over 90% of channel width.

DIGITAL STABILIZER

STABILIZATION MODE – Two point stabilization using spectrum reference peaks.
PEAK RANGE – Channel 2 to 8191.
PEAK WINDOW – 1 to 64 channels.
WINDOW SPACING – 2 to 256 channels, windows symmetrically positioned on either side of peak.
CORRECTION RANGE – Zero: ±1% of full scale; Gain: ±10% or ±1% of full scale, programmable.
CORRECTION RESOLUTION – 1 part in 4096.
RATE DIVIDER – 1, 2, 4 or 8.

PILEUP REJECTOR

PULSE PAIR RESOLUTION – ≤500 ns.
MINIMUM DETECTABLE SIGNAL – Limited by detector/preamplifier noise characteristics.

ACQUISITION

DATA MEMORY – 8192 channels; 32 bits per channel; battery-backed.
STORAGE MODE – PHA ADD.
ACQUISITION GROUP SIZE – Always 8192 channels.
DISPLAY GROUP SIZE – 8192, 4096, 2048, 1024, 512 or 256.
PRESET MODE – Live or Real Time (computational presets are performed by the host computer).
TIME RESOLUTION – 0.01 s.
PRESET TIME – 1 to $>10^7$ s.
TIMER STORAGE – Memory channels 1 (live time) and 2 (real time).

PHYSICAL

SIZE – 26.9 x 27.2 x 4.8 cm (10.6 x 10.7 x 1.9 in.).
WEIGHT – 3.2 kg (7.0 lb) with batteries.
OPERATING TEMPERATURE – 0-45 ±°C.
RELATIVE HUMIDITY – 8-80%, non-condensing.

ORDERING INFORMATION

Model 1250 InSpector Portable Workstation components include:
- InSpector acquisition electronics unit
- Genie-2000 Basic Spectroscopy Software (S504)
- PROcount-2000 Counting Procedure Software (S503)
- Serial communications cable (C1715-2)
- Composite quick disconnect detector cable; 3 m (10 ft) (C1711-10)
- AC adapter/charger
- Pair of Sony NP-98D (2.7 amp hr) or equivalent battery packs
- Carrying Case
- Consult factory for Genie-PC/OS/2 ordering information

OPTIONS

Model 1212 Cigarette Lighter Adapter (Sony).
S501 Genie-2000 Gamma Analysis Software.
S505 Genie-2000 Quality Assurance Software.

Special Composite Cables

C1712-10: 3 m (10 ft) composite cable tailored for NaI detectors.
C1713-10: 3 m (10 ft) composite cable tailored for box style preamps.
C1714-10: 3 m (10 ft) composite cable tailored for Reset Style (TRP or Optical Reset) preamps.
C1711-25: same as C1711-10, but 7.6 m (25 ft).
C1712-25: same as C1712-10, but 7.6 m (25 ft).

MINIMUM COMPUTER REQUIREMENTS

– 486 processor (486 and coprocessor recommended).
– 16 MB RAM memory (more will improve performance).
– 200 MB hard drive.
– Windows 95, Windows NT for Genie-2000 software.
– OS/2 for Genie-PC software.